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(12) # EUROPEAN PATENT SPECIFICATION

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DE-A- 2 434 214
DE-A- 2 550 178
DE-A- 2 704 686

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Description

This invention relates to cathode for use in the electrolytic refining or electrowinning of copper.

Conventional electrorefining and electrowinning plants which use copper starter sheets have an existing supply of iron hanger bars. In that stainless steel starter sheets are not easily welded to iron, mild steel or copper-clad bars, however, it normally is not practicable to use existing bars in a conversion to a stainless steel starter sheet system.

Welding of stainless steel to copper clad iron hanger bars by conventional use of monel, inconel or copper (1% tin) as filler material has not proven successful. Both monel and copper (1% tin) welds exhibit excessive corrosion in the electrolyte and inconel welds cause deformation of the hanger bar and perforation of copper cladding to expose the core metal.

Further, welding of stainless steel starter sheets to copper clad iron hanger bars deform the hanger bars by twisting or bending during the welding operation so that the starter sheets will not be suspended vertically from the hanger bars and provide problems with regard to the electrical contact between the starter sheets and the hanger bars.

According to DE-A 2 550 178 the problems of mechanical deformation and uneven electrical contact arising when a valve metal, e.g. titanium, starter sheet is attached to a copper bar by means of screws or rivets, are overcome by forming the hanger bar of, inter alia, copper with a core of a valve metal so that a portion of the core is exposed along the length of the bar, and then welding the hanger sheet to the exposed portion. According to one arrangement for doing this lugs formed by cutting the top edge of the starter sheet bent over alternately on either side of the hanger bar with their distal ends welded to the exposed surface of the valve metal core. The copper surrounds the core on three sides.

According the DE-A 2 704 686 said starter sheet can be made of stainless steel and the core to which the starter sheet is welded can be any compatible metal such as mild steel, stainless steel or iron.

It is an object of the present invention therefore to provide a re-usable cathode starter sheet of stainless steel joined to copper clad iron hanger bar thereby permitting retrofit and use of existing iron hanger bars with substantial savings and to provide a cathode structure having a good mechanical connection between the stainless steel starter sheets and copper clad hanger bars to enhance weldability of the starter sheets the hanger bars and to provide optimum electrical contact there between.

This object is solved by the features of claim 1.

Preferred embodiments of the invention are stated in the subclaims.

The invention will now be described in detail with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a preferred embodiment of the cathode of the present invention;

Figure 2 is a section taken along 2-2 of Figure 1;

Figure 3 is a section of an alternate embodiment taken along 2-2 of Figure 1;

Figure 4 is a perspective view of another embodiment of the present invention;

Figure 5 is a section taken along 5-5 of Figure 4; and

Figure 6 is a section of an alternate embodiment taken along 5-5 of Figure 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to Figures 1 and 2, the embodiment of the stainless steel cathode illustrated therein comprises a hanger bar 10 having an iron or mild steel core 12 with a copper cladding 14 tightly enveloping or bonded to core 12 from one end of the bar to the other. Copper cladding 14 preferably has a thickness in the range of about 2mm to about 4mm, preferably about 3mm.

An austenitic stainless steel plate or starter sheet 16 preferably formed of 316L stainless steel has a plurality of oppositely bent lugs 18, 20 formed along its upper edge initially diverging upwardly and outwardly at 22, 24 and then extending parallel to the plane of the sheet 16 close to or abutting side faces 26, 28 of copper clad hanger bar 10 to receive bar 10 therebetween. The free or distal ends 30, 32 of lugs 18, 20 are bent inwardly through at least about 90°, preferably about 93°, for alignment of the terminus 33 of each lug substantially with the centre line of the upper face 34 of hanger bar 10 for welding of said edges to the copper cladding, as depicted most clearly in Figure 2 by fillet welds 36. Sheet 16 thus is mechanically supported by the distal ends 30, 32 of lugs 18, 20 which bear on upper surface 36 of hanger bar 10 and are rigidly secured thereto by the welds 36 to ensure good electrical conductivity and to ensure that the vertical plane of sheet 16 is in alignment with the vertical centre line of the hanger bar, depicted by numeral 38, and is maintained perpendicular to the under surface 40 of the said hanger bar.

The opposite ends 42, 44 of hanger bar 10 extend laterally beyond the side edges 46, 48 of sheet 16 to permit seating of the hanger bar 10 on electrical support contacts in an electrowinning or electrofining cell, well known in the art and not shown.

Figure 3 illustrates another embodiment of the invention shown in Figure 1 wherein an intermediary stainless steel strip 44 is interposed between distal ends 30, 32 of lugs 18, 20 and the upper surface 34 of hanger bar 10 along the length thereof. Strip 44 preferably is explosion bonded to the copper cladding enveloping bar 10 to provide a good electrical and mechanical contact between strip 44 and the bar 10. The distal ends 30, 32 of lugs 18, 20 would therefore be welded to strip 44 by fillet welds 37, thus facilitating the effective welding of the sheet to the hanger bar.

Fiqure 4 illustrates another embodiment of our invention in which copper clad hanger bar 10 has a stainless steel sheet 50 secured thereto by means

of lugs 52, 54 and 56 welded to the opposite side faces 26, 28 of the hanger bar, as shown more clearly in Figure 5. Lugs 52, 54 and 56 have outwardly diverging oppositely inclined portions 58, 60 and 62, respectively terminating in distal portions 64, 66 and 68 which are parallel to and closely abut the opposite side faces 26, 28 of the hanger bar 10 for welding directly thereto by welds depicted by numeral 74 or for welding to intermediary stainless steel strips 70, 72 interposed between the lugs and the side faces as shown in Figure 6. Stainless steel strips 70, 72 preferably are explosion bonded to the side faces 26, 28 of the hanger bar to provide good electrical and mechanical contact therewith and to facilitate welding of the lugs to the hanger bar by welds depicted by numeral 76.

It has been found that low-temperature welds 36, 37 in the embodiments of Figure 1 and welds 74, 76 in the embodiments of Figure 4 can be made without warping or bending of the hanger bars and without perforation of the copper cladding by use of high silicon copper such as LINDE 26 (Trade Mark) filler wire having, by weight, 3.43% Si, 1.00% Mn and 0.17% Fe, the balance Cu. Welding wire having a diameter not greater than about 0.05 inches, preferably about 0.035 inches, applied by MIG arc welding under 100% argon shielding gas at 1.13 Cubic metres/hr applying 230 amperes at 27 volts (+ or - 5%) by a pulse power supply using a ESAB LAK PulseArc 350 (Trade Mark) machine with wire feed at 285mm/sec (+ or - 10%) provided suprisingly good welds which were corrosion-resistant in the electrolyte. The hanger bars were rigidly clamped at each end during welding and were substantially free of bending or twisting with flat stainless steel sheets secured thereto after completion of the welding operation.

It is believed the use of staggered lugs allowed possible distortion in the sheets due to expansion, notwithstanding the selection of relatively low-temperature filler metal, to be oriented in opposite directions along the top of the blank and thus be effectively cancelled. The embodiments of Figure 1 which have about 20 "opposed" lugs bent over the hanger bar were particularly resistant to distortion, the 3° angle of the lug to the plane of the upper bar surface obviating torsional deformity of the stainless steel sheet.

The present invention provides a number of important advantages. Steel or iron hanger bars can be used with stainless steel starter sheets by means of copper cladding the hanger bars and employing a novel sheet hanger configuration in combination with welds using copper-silicon filler metal to provide a warp-free structure which hangs vertically in electrorefining or electrowinning cells. Electrical conductivity and mechanical integrity of the resulting cathode structures are satisfactory and provide efficient electrolytic recovery of metal.

It will be understood, of course, that modifications can be made in the embodiments of the invention illustrated and described herein without departing from the scope and purview of the invention as defined by the appended claims.

Claims

1. A cathode for use in electrolytic refining or electrowinning of copper, comprising: a mild steel or iron hanger bar (10) having a rectangular cross-section providing flat upper and lower surfaces and flat opposite side surfaces; a copper cladding (14) enveloping said hanger bar; said hanger bar having end portions adapted to be seated on electrical contacts; a flat stainless steel starter sheet (16) having an upper edge with a plurality of lugs (18, 20; 52, 54, 56) formed along said upper edge, alternating lugs along said upper edge being bent in opposite directions to extend parallel to the plane of the sheet (16) close to or abutting opposite side faces (26, 28) of the copper-clad hanger bar, said stainless steel lugs being welded to the copper clad hanger bar (10) using high silicon copper wire for welding.

2. A cathode as claimed in Claim 1 wherein said alternating lugs (18, 20) are bent inwardly to overlap the copperclad hanger bar upper face (34) and the lugs are welded to the copper-clad hanger bar on said upper face.

3. A cathode as claimed in Claim 2 wherein said lugs are bent inwardly through about 93° whereby lugs define an angle of about 93° whereby lugs define an angle of about 3° to the hanger bar flat upper surface.

4. A cathode as claimed in Claim 1 wherein said alternating lugs are welded to the opposite side faces (26, 28) of the copper-clad hanger bar.

5. A cathode as claimed in one of the claims 1–4 wherein high silicon copper wire contains by weight 3.43% Si, 1.0% Mn and 0.17% Fe, the balance copper.

6. A cathode as claimed in one of the Claims 1 to 5 wherein at least one stainless steel strip (44; 70, 72) is interposed between the alternating lugs and the copper cladding (14), said stainless steel strip being explosion bonded to the copper cladding (14) and the stainless steel lugs being welded to the stainless steel strip.

Revendications

1. Cathode destinée à s'utiliser dans l'affinage électrolytique ou la récupération électrolytique du cuivre, comprenant: une barre de suspension en acier doux ou en fer (10) présentant une section transversale rectangulaire comportant des surfaces planes supérieure et inférieure et des surfaces latérales opposées planes; un gainage en cuivre (14) enveloppant cette barre de suspension; cette barre de suspension comportant des parties extrêmes destinées à s'appuyer sur des contacts électriques; une feuille d'amorçage ou cathode plane en acier inoxydable (16) présentant un bord supérieur comportant une série d'oreilles (18, 20; 52, 54, 56) formées le long de ce bord supérieur, les oreilles alternées le long de ce bord supérieur étant courbées dans des directions opposées pour s'étendre parallèlement au plan de la feuille (16) au voisinage des faces latérales opposées ou en contact avec ces faces latérales opposées (26, 28) de la barre de suspension gainée de cuivre, ces oreilles en acier

inoxydable étant soudées à la barre de suspension gainée de cuivre (10) en utilisant un fil de cuivre à haute teneur en silicium pour le soudage.

2. Cathode suivant la revendication 1, caractérisée en ce que les oreilles alternées (18, 20) sont inclinées vers l'intérieur pour surplomber la face supérieure (34) de la barre de suspension gainée de cuivre, et les oreilles sont soudées à la barre de suspension gainée de cuivre sur cette face supérieure.

3. Cathode suivant la revendication 2, caractérisée en ce que les oreilles sont inclinées vers l'intérieur suivant un angle d'environ 93°, de manière que les oreilles définissent un angle d'environ 3° par rapport à la surface supérieure plane de la barre de suspension.

4. Cathode suivant la revendication 1, caractérisée en ce que les oreilles alternées sont soudées aux faces latérales opposées (26, 28) de la barre de suspension gainée de cuivre.

5. Cathode suivant l'une quelconque des revendications 1 à 4, caractérisée en ce que le fil de cuivre à haute teneur en silicium contient en poids 3,43% de Si, 1,0% de Mn et 0,17% de Fe, le reste étant du cuivre.

6. Cathode suivant l'une quelconque des revendications 1 à 5, caractérisée en ce qu'au moins une bande en acier inoxydable (44; 70, 72) est interposée entre les oreilles alternées et le gainage en cuivre (14), cette bande en acier inoxydable étant liée par explosion au gainage de cuivre (14), les oreilles en acier inoxydable étant soudées à cette bande en acier inoxydable.

Patentansprüche

1. Kathode für die elektrolytische Abschneidung bzw. Gewinnung von Kupfer, mit einer Hängeschiene (10) aus Weichstahl oder Eisen von rechteckigem Querschnitt, wobei die Hängeschiene eine flache obere Außenfläche, eine flache untere Außenfläche und zwei flache seitliche Außenflächen sowie einen sie umhüllenden Überzug (14) aus Kupfer aufweist und ihre Endabschnitte auf elektrische Kontakte aufsetzbar sind, und mit einer flachen Starterplatte (16) aus rostfreiem Stahl, an deren oberen Rand über ihn verteilt eine Vielzahl von fahnenartigen Ansätzen (18, 20; 52, 54, 56) ausgebildet ist, wobei aufeinanderfolgende Ansätze aus rostfreiem Stahl in entgegengesetzter Richtung abgebogen sind und sich auf den entgegengesetzten Seiten nahe den seitlichen Außenflächen (26, 28) der kupferüberzogenen Hängeschiene (10) bzw. an diesen anliegend parallel zur Ebene der Platte (16) erstrecken und an der kupferüberzogenen Hängeschiene (10) unter Verwendung von Kupferdraht mit hohem Siliziumgehalt angeschweißt sind.

2. Kathode nach Anspruch 1, bei der die einander sich abwechselnden fahnenartigen Ansätze (18, 20) so nach innen abgebogen sind, daß sie die obere Außenfläche (34) der kupferüberzogenen Hängeschiene überlappen, wobei sie an dieser oberen Außenfläche angeschweißt sind.

3. Kathode nach Anspruch 2, bei der die fahnenartigen Ansätze um 93° nach innen abgebogen sind, so daß die Ansätze einen Winkel von etwa 3° mit der oberen Außenfläche der Hängeschiene einschließen.

4. Kathode nach Anspruch 1, bei der die aufeinanderfolgenden Ansätze an den seitlichen Außenflächen (26, 28) der kupferüberzogenen Hängeschienen auf entgegengesetzten Seiten angeschweißt sind.

5. Kathode nach einem der Ansprüche 1 bis 4, bei der der Kupferdraht mit hohem Siziliumgehalt gewichtsmäßig 3,43% Si, 1,0% Mn und 0,17% Fe enthält und der Rest aus Kupfer besteht.

6. Kathode nach einem der Ansprüche 1 bis 5, bei der mindestens ein Streifen (44; 70, 72) aus rostfreiem Stahl zwischen den Ansätzen und dem Kupferüberzug (14) eingefügt ist, wobei der Streifen aus rostfreiem Stahl mit dem Kupferüberzug (14) verbunden ist durch "explosion bond" und die Ansätze aus rostfreiem Stahl an dem Streifen aus rostfreiem Stahl angeschweißt sind.

FIG. 1.

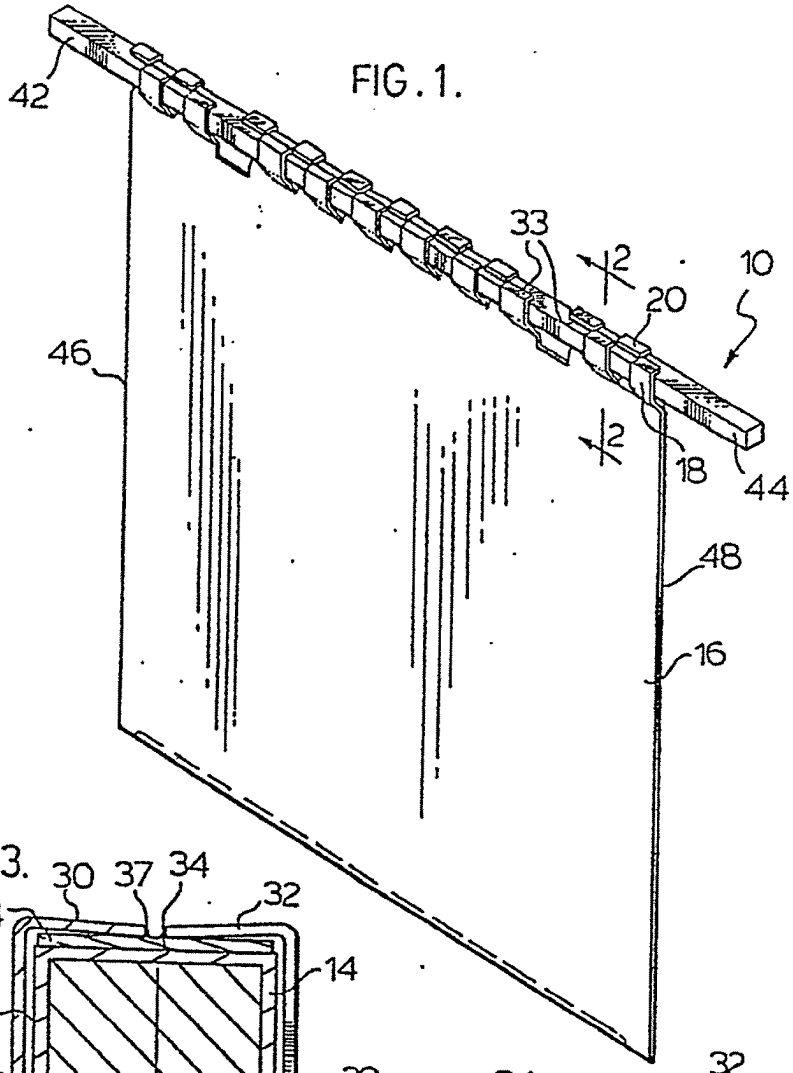
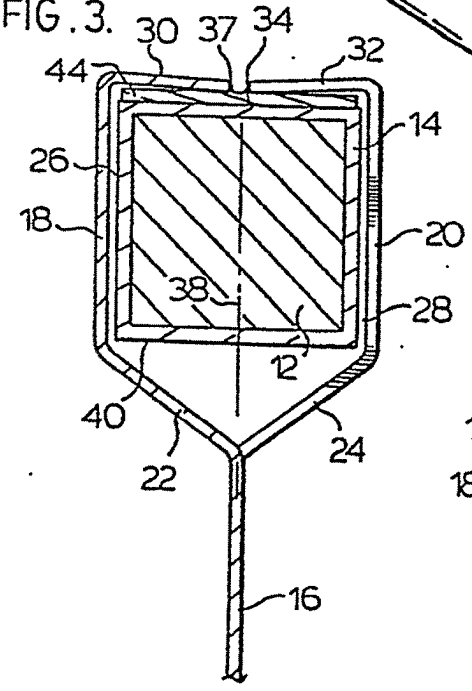


FIG. 3.



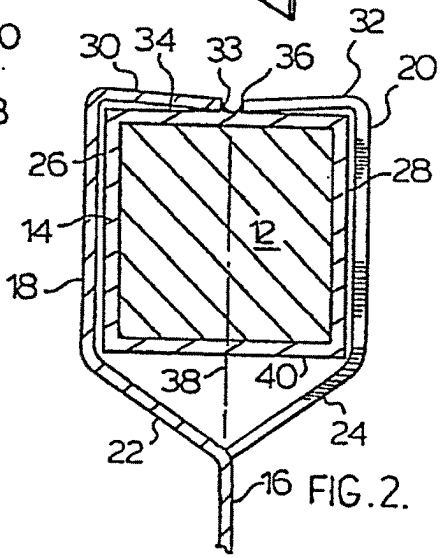


FIG. 2.

FIG. 4.

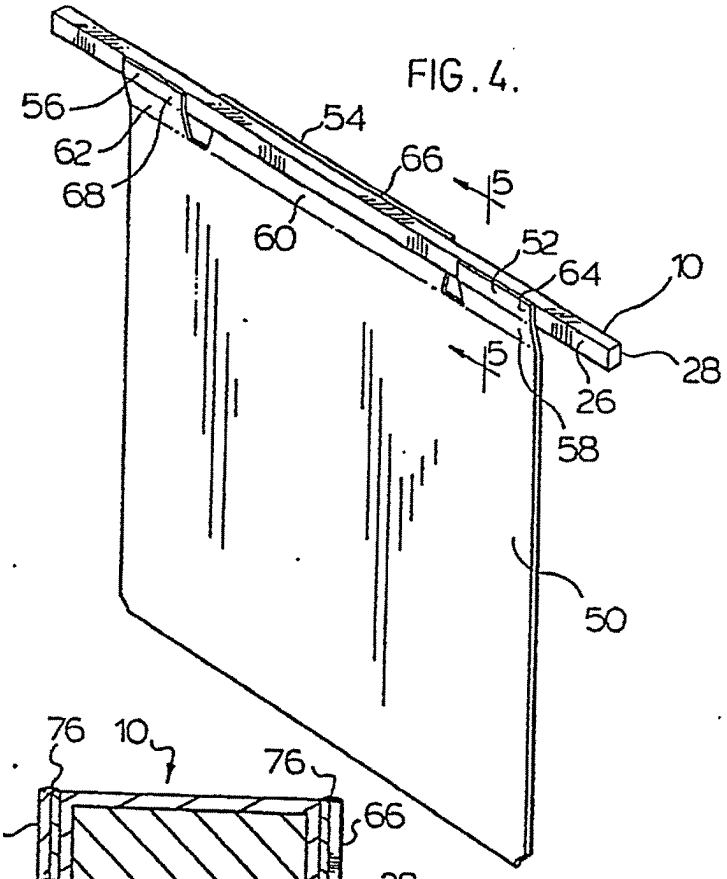


FIG. 6.

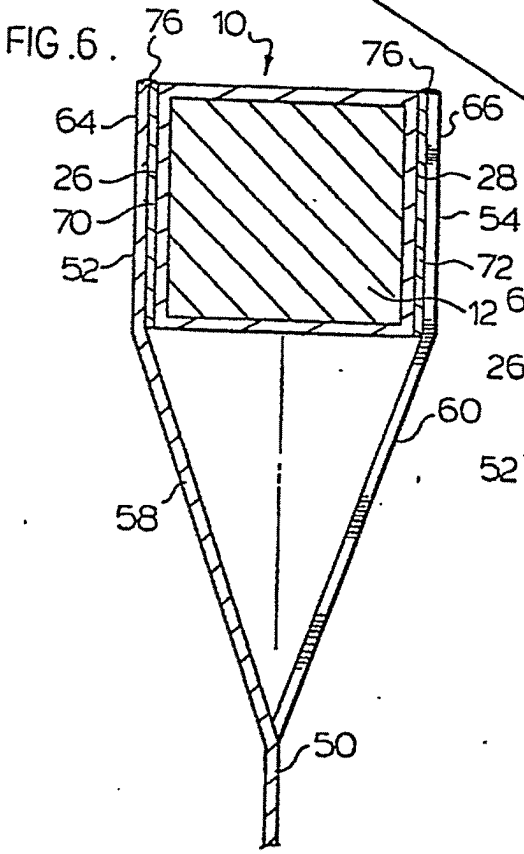


FIG. 5.